

**Emerging Technologies and the Role of Special Border Platoons: Modernizing Defense Capabilities and Combating Cross-Border Crime in the Brazilian Amazon***Emerging Technologies and the Role of Special Border Platoons: Modernizing Defense Capabilities and Combating Cross-Border Crime in the Brazilian Amazon***Bruno de Alcântara Barbosa da Silva** - Graduate in Applied Sciences, Military Sciences - Agulhas Negras Military Academy, Resende – RJ**George Eduardo de Sousa Lopes** - Graduate in Applied Sciences, Military Sciences - Agulhas Negras Military Academy, Resende – RJ**Abstract**

Defending the Amazon has never been an easy task. The vastness of the territory, the difficulties of access, and the increasingly organized presence of criminal groups make the northern border a constant challenge for the Brazilian state. It is there, where the map blends into the forest, that the Special Border Platoons (PEF) fulfill their role as advance sentinels. More than just military posts, they are points of national presence: they keep the country's eye on regions where the state has almost no reach, support joint operations, and serve as a bridge to isolated communities. In recent years, technology has begun to change this routine. Drones, thermal sensors, satellite communication, and geospatial intelligence systems have expanded the scope of actions and reduced the isolation of garrisons. Border combatants no longer rely solely on sight and experience — they now also operate with real-time data, images, and information. The rugged soldier has become a technical operator, without losing the essence of the jungle. Even so, there are obstacles that remain in the way: difficult logistics, doctrinal limitations, and resources that do not always keep pace with innovation. True modernization still depends on continuity, integration, and constant presence. In short, defending the Amazon in the future will not be just a matter of patrols or equipment. It will depend on the balance between three pillars: technology, human presence, and institutional cooperation. Together, they ensure that surveillance is not just observation, but also deterrence; and that sovereignty is maintained, not in discourse, but on the ground where it is put to the test every day.

Keywords: Amazon; borders; Special Border Platoons; military technology; transnational crime.

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presence. In short, the defense of the Amazon in the future will not be merely a matter of patrolling or equipment. It will depend on the balance between three pillars—technology, human presence, and institutional cooperation. Together, they ensure that surveillance is not just observation, but also deterrence; and that sovereignty is maintained, not in discourse, but on the ground where it is put to the test every day.

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1. Introduction

The defense of the Amazon has always played a central role in Brazil's national strategy. More than just a vast territory, it is a vital region—home to a significant part of the planet's biodiversity and immense reserves of fresh water. Brazil shares more than 4,000 kilometers of borders with countries that share the same forest, forming a natural continuum that is difficult to monitor. The limited presence of the state and logistical challenges make this strip particularly sensitive to the activities of illicit groups.

In recent decades, the Brazilian Army has taken the lead in the state's presence in these remote areas. In this context, the Special Border Platoons (PEF) have become the most concrete symbol of this presence. Installed in restricted access locations, they not only defend the territory but also perform social and administrative functions. They provide medical support to riverside communities, collaborate in environmental operations, and serve as a base for civilian agencies during interagency missions. In many parts of the Amazon, the flag flying at a PEF is the only visible sign of national authority.

The jungle, however, imposes severe limits on traditional surveillance methods. The density of vegetation, the unpredictability of rivers, and the lack of road infrastructure make any trip a long and exhausting operation. At the same time, criminal organizations have quickly adapted to this environment. Factions that previously operated only in large cities have begun to exploit the Amazon's river and air routes, taking advantage of geographical gaps and failures in state coverage. The terrain, once a natural obstacle, has become the main ally of these transnational networks.

In this new scenario, technology is no longer an accessory but has become decisive. Tools such as drones, infrared sensors, satellite communication systems, and digital mapping have transformed the way operations are conducted at the border. What used to take days of travel can now be observed in minutes. Information that used to take time to reach headquarters is now transmitted in real time, shortening distances and multiplying response capacity.



This article analyzes how this technological incorporation is redefining the role of the Special Border Platoons. The study is structured around three main axes:

1. The strategic and symbolic role of the PEF in territorial defense;
2. The characteristics of the Amazonian operational environment and the dynamics of transnational crime;
3. The concrete impacts of emerging technologies on the efficiency and security of operations.

More than a technical debate, the aim is to understand the meeting point between tradition and modernization. Between the rusticity required by the jungle and the digital precision of new tools, a new profile of the border combatant emerges—a professional who combines empirical experience with data analysis, capable of operating both on the ground and in the information domain.

2. The strategic role of special border platoons

Special Border Platoons represent the most direct manifestation of Brazilian sovereignty in the Amazon. Located in remote areas that are difficult to access and often isolated for long periods, these detachments serve as the line of contact between the state and territories where institutional presence is minimal.

The function of these units goes beyond military surveillance. In practice, PEFs are logistical, social, and even symbolic points of support. In many riverside communities, they are the only permanent representation of public authority, responsible for providing emergency medical care, transportation, humanitarian aid, and support to civil agencies. This constant interaction with the local population reinforces the bond of trust and expands the reach of state authority, making the troops not only an instrument of defense but also an agent of national integration. From an operational standpoint, PEFs perform activities ranging from river and land patrols to reconnaissance and intelligence operations. These units operate continuously, rather than episodically, which allows them to accumulate in-depth knowledge about the terrain, communities, and regional dynamics. This prolonged experience generates a type of intelligence that no technology can replace—an understanding of local movement patterns, routes used by criminal groups, and seasonal changes that influence mobility in the forest.

In strategic terms, this territorial permanence is what differentiates the Border Special Platoons



from conventional operations. While large units mobilized occasionally project power, the PEFs consolidate their presence. This difference is fundamental in the Amazon, where the simple removal of a garrison can mean the immediate emergence of illegal activities.

The interagency dimension of PEF operations is another crucial aspect. At the borders, combating organized crime depends not only on military power, but also on the ability to coordinate between different state agencies. The platoons often serve as an advanced base for the Federal Police, Federal Revenue Service, IBAMA, ICMBio, and other institutions, providing logistical support, infrastructure, and security. This integration is vital for joint operations to combat drug trafficking, illegal mining, and environmental devastation.

However, even with such relevance, the challenges are significant. The difficulty of replenishing supplies, the small number of personnel, the hostile climate, and the immense distances between posts impose significant operational limitations. Many platoons still depend on river travel lasting several hours or days to carry out basic reconnaissance missions, which compromises their ability to respond quickly to critical events.

The presence of the PEFs, therefore, must be understood as a delicate balance between rusticity and modernization. These units carry the weight of Brazilian military tradition in the jungle, but now need to incorporate new tools and concepts to deal with an enemy that operates in networks, with high mobility and access to technology. Strengthening these platoons means investing in the front line of sovereignty, ensuring that the state not only reacts, but remains, knows, and controls.

3. Operational environment of the Amazon and dynamics of transnational crime

The Amazonian environment poses unique challenges to territorial defense. It is a region marked by extensive areas of dense forest, low population density, and a complex hydrographic network, which functions simultaneously as a communication route and a strategic vulnerability. This geographical configuration creates a border that is difficult to control, where rivers, streams, and secondary channels extend for thousands of kilometers, connecting neighboring countries without natural barriers capable of restricting the movement of people and goods.

Unlike regions where borders are based on well-defined geographical features, such as mountains or deserts, in the Amazon the dividing line is fluid. In many



sections, the border is represented only by a river, and simply moving from one bank to the other means crossing between countries. This type of structural porosity favors the circulation of legal and illegal products, increasing the challenge for security forces.

The Amazonian rivers are both a source of life and a route of vulnerability. They serve as logistical corridors connecting isolated villages to urban centers, but also as preferred routes for trafficking drugs, weapons, gold, and timber. Criminal groups use small, fast, shallow-draft boats that easily blend in with local traffic. The use of powerful engines, combined with detailed knowledge of the terrain, gives these organizations greater mobility than security forces, especially at night or in adverse weather conditions.

The absence of radar coverage in much of the region, coupled with the lack of road infrastructure and stable communications, makes monitoring these routes extremely difficult. For a long time, surveillance was based solely on direct observation by the military and information provided by local communities—an effective model on a small scale, but insufficient given the speed and adaptability of illicit groups.

Crime in the Amazon has evolved in a similar way to the geography itself: diffuse, interconnected, and resilient. Drug trafficking, traditionally concentrated on Andean routes, began to use the Amazon as a corridor, connecting production centers in Peru and Colombia to Brazilian ports on the Atlantic coast. This network, sustained by alliances between national factions and foreign organizations, transformed the forest into a strategic transit zone.

In addition to drug trafficking, the region is also home to other forms of transnational crime. Illegal mining, which has intensified in recent decades, has expanded into environmentally protected areas and indigenous lands, causing ecological damage and social conflicts. In many cases, mining operations are financed by criminal factions that use gold extraction as a means of money laundering. The smuggling of weapons and ammunition, in turn, fuels violence in distant urban centers, demonstrating how the
Instability at the border has repercussions throughout the country.

Another key aspect is the vulnerability of riverside and indigenous communities, which are often marginalized by public policies. In these areas, the state's presence is manifested almost exclusively through Special Border Patrols. In contrast, criminal groups exploit the institutional absence by offering transportation,



supplies, medicines, and even "security" in exchange for silence and logistical support. This relationship of dependency creates zones of influence where crime partially replaces state authority, making it difficult to obtain information and community cooperation.

In addition to human factors, there is a significant technological asymmetry. While criminal organizations are quick to adopt encrypted communication tools, GPS navigation systems, and geolocation applications, many military units still operate with limitations in terms of power, signal, and equipment. This difference in technological capacity widens the gap between the speed of illegal actions and the response capacity of law enforcement.

To address this scenario, it is necessary to understand that transnational crime in the Amazon is not just a police problem, but a geostrategic phenomenon. Its ramifications touch on the economy, environmental policy, international relations, and the very credibility of the state in the region. Therefore, defending the Amazon border requires an integrated approach that combines physical presence, technological surveillance, and permanent interagency cooperation.

4. Emerging technologies applied to border operations

Defending the Amazonian borders has always required more than just a physical presence. The hostile terrain, distance from logistics centers, and unpredictable nature of the jungle test the endurance and ingenuity of troops. In recent years, however, technological advances have begun to transform this reality. Tools once restricted to high-investment theaters of operations have become part of the daily routine of the Special Border Platoons (PEF), multiplying their efficiency and reducing operational isolation.

These small units, which for decades depended on limited-range radio communications and time-consuming river travel, now have resources that significantly expand their surveillance, decision-making, and response capabilities. Among the most impactful tools are drones, thermal sensors, satellite communication systems, and geospatial intelligence platforms — technologies that, when combined, allow troops to act in an integrated, precise, and real-time manner, even in the most remote parts of the Amazon.

a. Drones and precision aerial surveillance

The use of drones in jungle operations has become an essential part of the PEF's routine. Small, silent, and easy to transport, these devices allow for the observation of



in a matter of minutes — a task that previously required numerous patrols and days of marching under adverse conditions.

The benefits are immediate: less exposure for troops, time savings, and access to accurate visual information. The detection of camouflaged camps, boats hidden under vegetation, or clandestine landing strips has become faster and safer. In many situations, images are transmitted in real time to the operations center, allowing for immediate adjustments to maneuvers or the dispatch of reinforcements to critical points.

More than just surveillance, drones have become part of a strategy of anticipation. By recording movement patterns, they help identify organized crime routes and recurring times of activity. This ability to "see before acting" redefines the concept of patrolling and reinforces the deterrent nature of the military presence at the border, which now relies on both force and intelligence.

b. Thermal sensors: vision beyond the forest

For a long time, the Amazon canopy was a natural ally of illicit activities. The dense cover prevented aerial observation and limited visibility on the ground. The emergence of thermal sensors and infrared cameras has significantly changed this scenario.

This equipment detects subtle temperature differences, revealing human presence or running engines even under thick vegetation. At night, when the forest offered the enemy a total advantage, technology began to favor the combatant. It allows for planning movements, avoiding ambushes, and observing the enemy without being seen—tactical advantages that increase control of the terrain and troop safety.

Integrated into drones or long-range binoculars, thermal sensors increase patrols' situational awareness and reduce the risk of surprises. The decision to advance, retreat, or surround a point is now guided by concrete data, not assumptions. This represents a change in operational posture: troops no longer react only to contact but operate based on prediction and analysis, which improves the quality of command and combat efficiency.

c. Satellite communications: breaking isolation

Few challenges have impacted the work of Special Platoons as much as the lack of reliable communication. Between mountains, rivers, and dense forest, conventional radios often fail, leaving units isolated for days. The arrival of portable satellite communication systems has profoundly and permanently changed this landscape.



Today, even in the most remote regions, it is possible to transmit messages, coordinates, and images quickly and securely. This allows tactical decisions to be made almost in real time, medical evacuation requests to be responded to within minutes, and command to maintain effective control of the situation, regardless of distance or weather conditions.

Satellite communication also strengthens the interagency nature of border operations. Information captured by PEFs can be shared instantly with the Federal Police, IBAMA, or the Federal Revenue Service, facilitating joint actions against trafficking, smuggling, and illegal deforestation. This integration of efforts expands the reach of the state in the border area and reinforces the national presence in historically vulnerable areas.

d. Geospatial intelligence and integrated monitoring

The combination of sensors, drones, and satellite communications reaches its maximum potential when associated with geospatial intelligence systems. This is where information becomes decision-making power. Analytical maps, generated from the fusion of satellite images, seizure records, environmental data, and river flows, allow planners to identify critical areas and predict suspicious movements.

This type of analysis gives commanders the ability to deploy their forces predictively, concentrating efforts where the probability of illegal activity is highest. The border, once marked by reaction and slow communications, becomes an environment of active surveillance, where every decision is supported by concrete and up-to-date evidence.

More than a technical evolution, this transformation represents a new operational paradigm. Border combatants no longer act in isolation but are now part of an information network that increases their autonomy and security. Mastery of technology, combined with field experience, makes the Special Border Platoon a truly modern unit — capable of combining ruggedness and high technology to ensure national sovereignty in the Amazon.

5. The modernization of the border guard's profile

The technological transformation experienced in recent decades has brought about profound changes not only in the way border guards operate, but also in their professional identity. The traditional figure of the "jungle soldier," shaped by physical endurance, ruggedness, and mastery of the natural environment, now coexists with a new type of military personnel—more technical, analytical, and connected. War in the forest is no longer fought only with



compass, machete, and radio, but also with sensors, screens, and algorithms.

This new reality requires a hybrid profile, combining the adaptability and instinct of the traditional combatant with the technical precision of the modern operator. The border soldier needs to know how to track footprints in the mud and, at the same time, interpret images transmitted by a drone. He must master river navigation with the same level of confidence with which he handles georeferencing software. Rusticity, once sufficient to ensure survival, is now just one component of professional competence.

The training process for this new operator is still evolving. Jungle training, the basis of Amazonian doctrine, remains indispensable: knowing the terrain, identifying the sound of rain, the flow of water, and the behavior of wildlife is what differentiates the local combatant from any external operator. However, the contemporary jungle is also a digitized environment. Every trail can be mapped by sensors, every movement can generate data, and every tactical action depends, to some extent, on network communication.

This interdependence between the physical and the informational changes the way we think about war. The military no longer acts only as an executor, but as a decision-making element within an information chain. It collects data, interprets signals, and is often the first to identify patterns that anticipate threats. The PEF is no longer just a unit of presence but also a node of territorial intelligence.

Mastering these new tools requires a more flexible and autonomous type of reasoning. Decisions in the field are increasingly rapid and require refined judgment, as the volume of information received in real time can both broaden and confuse perception. In this sense, the training of the modern border combatant includes the development of cognitive and emotional skills, such as the ability to prioritize data, remain calm under pressure, and make decisions based on uncertainty.

Another determining factor is the need for interagency integration. Today's border operator works in constant contact with civil, environmental, and law enforcement agents. They must understand different protocols and often translate military language into instructions that are understandable to other agencies. This communication skill, rarely emphasized in old doctrines, today it is fundamental to the success of joint operations.

In addition, the reality of the Amazon imposes its own psychological challenge. Prolonged isolation, extreme environmental conditions, and frequent contact with risky situations demand emotional balance and mental discipline. Combatants must maintain their lucidity amid monotony, humidity, and loneliness, without losing their readiness. Technology



reduces some of these difficulties, but does not eliminate the human factor. What defines the success of operations is still the individual's ability to endure and adapt to the environment.

Finally, the new profile of the border combatant reflects the evolution from a model of warfare focused solely on physical strength to one that equally values intellect and situational awareness. The modern operator is simultaneously a soldier, analyst, and communicator — someone who interprets the terrain with both their body and data. The jungle, once the exclusive domain of rusticity, has now become a laboratory for the integration of tradition and modernity.

6. Operational results — how technology has changed the border

The arrival of new technologies in border operations has already changed the way they operate. The clearest reflection of this is in the posture of the troops: the state no longer reacts only after the fact, but acts before. The combatant's gaze, once limited to what was within visual range, now sees kilometers of forest with the help of sensors and drones.

Today, Special Border Platoons are able to monitor large stretches of rivers and detect suspicious movements before illegal activities take place. This has changed the logic of patrols. Instead of long blind sweeps, movements are guided by concrete data. Less risk, less wear and tear, and more consistent results—more seizures, fewer confrontations.

Satellite communication has shortened time and space. A request for support, which used to take hours, is now transmitted almost immediately. Images and reports reach headquarters while the operation is still underway. This agility has enabled faster responses, better coordination, and a more reliable logistical flow.

From a security standpoint, the difference is enormous. Thermal cameras and aerial surveillance have reduced ambushes and incidents involving isolated patrols. Soldiers no longer advance "blindly" — they see the terrain beforehand, trust what they observe, and act with greater confidence. This changes troop morale. Night operations, which have always been a point of tension, have become more controlled and planned.

Another clear gain is coverage. Even with limited personnel, platoons are able to cover much larger areas than before. Remote monitoring, combined with fixed sensors, allows for constant surveillance of river stretches and clearings. The advantage of surprise, which previously favored criminals, now tends to be on the side of the state. There is also a psychological effect. The mere presence of drones flying over the area



or the news that there is real-time monitoring causes many illicit groups to change their behavior. They alter routes, reduce cargo, or suspend activities. Technology has become a deterrent—a silent warning that the territory is being observed.

The social impact is no less significant. Riverside residents, accustomed to long periods without any assistance, now feel the presence of the state more closely. Responses are quick, communication works, and the sense of protection increases. This creates a bond of trust between communities and troops, which in turn improves the flow of information and local cooperation.

In the area of intelligence, the results are also multiplying. Data collected by sensors, drones, and patrols are combined in maps that reveal movement patterns and points of interest. This integration means that knowledge is no longer just tactical—it now serves strategic planning and public policy formulation. What was once isolated is now systemic.

Ultimately, technology does not replace humans. It amplifies them. It is the military who interpret the data, make decisions, and apply the judgment that no machine has. The jungle remains a human environment, and it is this combination — sensitivity, experience, and tools — that defines the new era of border operations.

7. Challenges and paths for the future

Despite the progress, maintaining a modern and functional system in the Amazon is a huge challenge. The problem is not only technical—it is structural. Logistics, doctrine, training, integration, and political continuity form a whole that must work in harmony.

The first obstacle is the jungle itself. Humidity, heat, rain, and weather easily destroy electronics. Drones, batteries, and sensors require constant maintenance. Spare parts travel long distances by river to reach their destination. Without structured regional support, the useful life of the equipment decreases, and operating costs rise.

The second point is technical preparation. Buying equipment is easy; operating it well is another story. It is necessary to train personnel and create doctrine. The operator must understand what the machine shows, know its limits, and decide what to do with the information. Quick courses are not enough—training must be continuous, adapted to the natural turnover of



personnel in PEFs.

Integration between institutions is still partial. The Army, Federal Police, IBAMA, Internal Revenue Service, and other agencies work together, but with different systems, their own protocols, and isolated databases. This hinders interoperability. Joint command and control centers, with single protocols and a shared database, would be an important step.

There is also the issue of budget. Maintaining cutting-edge technology is expensive. And it is not enough to buy: it is necessary to update, replace, and train. Without predictable resources, modernization is lost in cycles — sometimes advancing, sometimes abandoning. The defense of the Amazon needs to be treated as a state policy, with constant investment and long-term goals.

In the doctrinal field, the challenge is cultural. The Brazilian Army is a world reference in jungle warfare, but modern combat in the Amazon involves much more than rusticity. Today's enemy operates in networks, uses technology, and moves quickly. Doctrine needs to reflect this, without losing the lessons of the jungle, but adapting to the new type of hybrid warfare.

Even with so many obstacles, the horizon is promising. Advances in artificial intelligence, low-orbit satellite communications, and smaller, more resistant sensors promise to further expand the range of surveillance. Long-range drones, portable radars, and interconnected sensor networks can give PEFs almost complete situational awareness, even in places where humans can barely reach.

The challenge will be to maintain a balance between innovation and sustainability. The Amazon is more than a military theater—it is a living ecosystem. Defending the border also means preserving the environment and respecting the communities that inhabit it. The future of operations depends as much on technology as it does on the trust built with these peoples. They are, in many cases, the first to see, hear, and warn.

In short, the future of Amazonian defense rests on three pillars: constant presence, quality information, and real integration between institutions. When these factors come together, the border ceases to be vulnerable and becomes a line of sovereignty. Permanence, knowledge, and cooperation — that is what, in practice, keeps Brazil standing in the Amazon.

Conclusion

Protecting the Amazon in the 21st century is more than a military mission—it is a test of the Brazilian state's maturity. The vastness of the territory, the natural difficulties, and the



advance of transnational criminal networks are forcing the country to reinvent its presence. In this context, the Special Border Platoons remain the most advanced line of sovereignty. Where the state is rare, they are permanent.

The introduction of emerging technologies has changed the game. Drones, sensors, satellite communications, and geospatial intelligence systems are no longer one-off resources but have become an essential part of the routine. These instruments broaden the troops' view, shorten distances, and allow the command to act with almost immediate precision. But they demand something in return: technical preparation, updated doctrine, and logistical support compatible with the jungle.

The border combatant has also changed. He remains the same man forged in the harshness of the jungle, but now operates in a hybrid environment. He uses sophisticated equipment, interprets data, and makes decisions in seconds. He is a professional who combines the instinct of the bush with the reading of digital maps. This fusion of tradition and technology is perhaps the real secret to effectiveness in the Amazon.

The challenges, however, remain concrete. The jungle takes a heavy toll on every piece of equipment. Integration between institutions is still partial. And investment is sometimes irregular. Modernization is not just about buying — it is about maintaining, training, and consolidating. Technology needs to become routine, not the exception. Similarly, interagency cooperation must cease to depend on individual will and become a permanent structure.

The future of Amazonian defense will depend on three simple and difficult factors: continuous presence, mastery of information, and effective coordination. When these elements come together, surveillance becomes deterrence, and the border becomes a real barrier to crime.

The Special Border Platoons represent this synthesis between past and future. Technology does not replace man—it expands his reach and reinforces his courage. Modernizing the PEFs is reaffirming Brazil's commitment to the Amazon, its sovereignty, and the populations that live there.

The forest will remain Brazilian as long as there is presence, knowledge, and will. And that is what, in the end, defines the true defense of the Amazon.

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